

Environmental Studies Program: Ongoing Study

Study Area(s): Central Gulf of Mexico

Administered By: Gulf of Mexico OCS Region

Title: Quantifying Changes to Infaunal Communities Associated with Several Deep-Sea Coral Habitats in the Gulf of Mexico and their Potential Recovery from the DWH Oil Spill

BOEM Information Need(s) to be Addressed: The DWH oil spill was responsible for changes in multiple ecosystems within the GOM, leading to shifting baselines within coastal and deep-sea ecosystems. However, estimates of baseline ecological conditions are scarce despite representing a critical component of long-term monitoring in the GOM. In addition to supporting large and valuable commercial and recreational fisheries, and numerous threatened or endangered species, the GOM OCS supports unique and diverse benthic communities, including deep-sea corals and chemosynthetic seeps, that are important to deep-sea ecosystem functioning and health. A few studies have documented the acute impacts of the spill to deep-sea communities, including soft sediments and corals. However, quantifying long-term changes and recovery of communities remains unresolved. This study will provide the long-term datasets that BOEM requires to measure the success of mitigations and terms required for developers to guarantee the protection of natural resources. In addition, these data will be useful for NEPA documents assessing the cumulative effects of the spill to these communities.

Total BOEM Cost: \$805,000 (USGS OCS Funds) **Period of Performance:** FY 2015–2018

Conducting Organization(s): USGS - Wetlands and Aquatic Research Center

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Description:

Background: Sediment macrofauna represent important indicators of oil-spill disturbance primarily due to their sedentary lifestyle and their rapid response to change; thus, examining these communities has proven useful in impact assessments of coastal and deep-sea communities. Monitoring of benthic infaunal communities will yield important insights into the patterns and trajectory of change within these ecosystems by identifying their sensitivity and resiliency to disturbance. As industry moves into deeper water, questions remain regarding impacts to deep-sea ecosystems. Therefore, it is imperative that monitoring efforts effectively identify and differentiate impacts from oil and gas activities from other forms of disturbance, including hurricanes and climate change.

BOEM has partnered with the USGS in several major research programs examining the distribution and community ecology of deep-sea coral ecosystems, including the

National Oceanographic Partnership Program-sponsored studies, Lophelia I and Lophelia II. Since 2004, the USGS DISCOVRE (<http://fl.biology.usgs.gov/DISCOVRE/>) program has provided ecosystem-based scientific reviews that meet the recommendations of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling final report to the President to methodically collect critical scientific data in areas that are being considered for oil and gas leasing.

While these multi-year studies have produced important baseline data, we lack information regarding the long-term impact of the DWH oil spill on benthic infaunal communities. In coordination with the BOEM Study Profile “Multidisciplinary Assessment of Deep-Water Coral Ecosystems: Tools to Detect Impacts of Sub-Lethal Stress”, this work will provide valuable data to help guide long-term monitoring programs of deep-sea environments. The research described here will provide the data necessary for impact assessments, and the information gathered will help inform the development of future restoration plans and delineation of protected areas.

Objectives: The primary objective is to document temporal change in deep-sea coral sediment community structure and function in order to track long-term responses to natural and anthropogenic disturbance. Specifically, we will assess changes in benthic infaunal communities following the DWH oil spill at several deep-sea coral sites located in proximity to the well head and at reference sites. Samples collected from 2007-2014 at deep-sea coral and chemosynthetic ecosystems will provide key time series information needed for identification of significant changes in benthic communities and trends in their response to disturbance, as well as factors responsible for these changes. This study will take advantage of data and samples presently in hand in order to represent the current baseline conditions in the deepwater GOM from which to establish long-term monitoring studies.

Methods: This task will characterize infaunal community structure at deep-sea corals in areas impacted by the spill compared to reference sites. Sediment cores (n=105) were collected from 19 BOEM lease blocks between 2007 and 2014. Pre-spill cores were collected at 6 lease blocks, while post-spill collections were collected at 17 lease blocks. ROV-deployed push cores were collected directly adjacent to deep-sea coral habitats and reference areas to assess infaunal abundance, diversity, evenness, and composition. Among these sites, there is at least one impacted coral site (White et al., 2012), and potentially two additional sites. While the pre-spill cores were not taken in the impacted sites, cores were collected at sites with similar coral species composition, allowing us to address temporal change in unimpacted deep-sea coral habitats. This work will also include comparing coral-associated infaunal communities to other habitats in the GOM, including seeps, soft-sediments, and shipwrecks for which we have existing data. These comparisons will quantify community changes since the spill, estimate resilience, and determine whether these systems have recovered to comparable community structures near healthy reference areas. We collected samples from different coral habitat types (e.g., octocorals, *L. pertusa*, *M. oculata*) to understand how different corals and their associated habitat heterogeneity may structure benthic communities. These samples will be used to quantify infaunal densities, diversity, and community composition of

macrofauna and for benthic environmental characterization, including sediment organic carbon, nitrogen, particle size, and redox potential.

Macrofaunal diversity will be examined with PRIMER Statistical Software. Similarities and differences in benthic communities will be examined using non-metric multidimensional scaling (MDS), based on Bray-Curtis similarity indices. Comparisons will be made among sites, habitat types, and years using Analysis of Similarity (ANOSIM) and permutational ANOVA (PERMANOVA). Similarity percentages (SIMPER) will determine the percent dissimilarity/similarity within the comparisons and the taxa responsible for differences between groups. Relationships of community structure to environmental variables will be assessed with distance-based linear models (DistLM) and distance-based redundancy analysis (dbRDA).

Current Status: Ongoing work involves sediment sorting, taxonomic identification, and data analysis of previously collected samples in the context of the larger time-series data set for continued monitoring of benthic communities.

Final Report Due: April 30, 2018

Publications Completed:

Journal Articles:

Demopoulos, A.W.J., Bourque, J.R., Cordes, E.E., Stamler, K.M. 2016. Impacts of the Deepwater Horizon oil spill on deep-sea coral sediment communities. *Marine Ecology Progress Series*, 561: 51-68, doi: 10.3354/meps11905

Prouty, N.G., Campbell, P.L., Mienis, F., Duineveld, G., Demopoulos, A.W.J., Ross, S.W., and Brooke, S., 2016, Impact of Deepwater Horizon spill on food supply to deep-sea benthos communities. *Estuarine, Coastal and Shelf Science*, v. 169, p. 248-264.

Prouty, N.G., Fisher, C.R., Demopoulos, A.W.J., and Druffel, E.R., 2016, Growth rates and ages of deep-sea corals impacted by the Deepwater Horizon oil spill: Deep Sea Research Part II: Topical Studies in Oceanography, v. 129, p. 196-212, doi:10.1016/j.dsr2.2014.10.021

Cordes, E.E., Berlet, S.P., Cardman, Z., Dannenberg, R., Demopoulos, A.W.J., Georgian, S.E., King, C., McKean, D.L., and Young, D.M., 2014, Exploring deep-sea coral communities and the effects of oil and gas inputs to the Gulf of Mexico. *Oceanography*, v. 27(supplement), no. 1, p. 34-35, doi:10.5670/oceanog.2014.supplement.01.

Fisher, C.R., Demopoulos, A.W.J., Cordes, E.E., Baums, I.B., White, H.K., Bourque, J.R. 2014. Coral communities as indicators of ecosystem-level impacts of the Deepwater Horizon spill. *Bioscience*, 64(9): 796-807.

Published Abstracts:

Demopoulos A.W.J., Bourque J.R., Fisher C.R., Cordes E.E. 2017. Temporal variability of deep-sea coral-associated polychaete communities in Gulf of Mexico sediment after the Deepwater Horizon oil spill. Gulf of Mexico Oil Spill and Ecosystem Science Conference, New Orleans, LA, Feb. 2017.

Bourque J.R., Demopoulos A.W.J. 2016. How do different species of deep-sea corals structure adjacent soft-sediment communities? 6th International Symposium on Deep-Sea Corals, Boston, MA, Sept. 2016.

Bourque J.R., Demopoulos A.W.J., Fisher C.R. 2016. Temporal variability of deep-sea coral-associated macrofauna in Gulf of Mexico sediment after the Deepwater Horizon oil spill. 2016 Gulf of Mexico Oil Spill & Ecosystem Science Conference, Tampa, FL, Feb. 2016.

Bourque J.R., Demopoulos A.W.J., Fisher C.R. 2015. Temporal variability of deep-sea coral-associated macrofauna in the Gulf of Mexico after the Deepwater Horizon oil spill. 14th Deep Sea Biology Symposium, Aveiro, Portugal, Sept. 2015.

Demopoulos A.W.J., Bourque J.R. 2015. Post-spill response of cold-water coral associated benthos in the Gulf of Mexico after the Deepwater Horizon oil spill. Gulf of Mexico Oil Spill and Ecosystem Conference, Houston, Texas, Feb. 2015.

Washburn, T.W., Demopoulos, A.W.J., Montagna, P., and Joye, S. Natural vs. anthropogenic oil: an ecological comparison. Gulf of Mexico Oil Spill and Ecosystem Science Conference, Houston, Texas, Feb. 2015.

Demopoulos, A.W.J., 2014, Past and future outer continental shelf projects in the South Atlantic and Gulf of Mexico, BOEM-USGS Gulf of Mexico Research and Management Coordination Meeting, New Orleans, La., Dec. 2014.

Affiliated WWW Sites:

<https://marinecadastre.gov/epis/#/search/study/100155>

Revised Date: February 14, 2018